## HEX-AXIS HORIZONTAL MOVEMENT DYNAMIC SIMULATOR

~~BACKGROUND OF THE PRESENT INVENTION 1. Field of the Present Invention ——— This~~FIELD OF THE INVENTION

The invention relates to a hex-axis horizontal movement dynamic simulator~~,~~ and more particularly to ~~a~~ 6-degree~~-~~s-of~~-~~-freedom motion simulating equipment used in modular design.

BACKGROUND ~~2. Description of Prior Art ——— Since the~~OF THE RELATED ART

An early structure of ~~the~~a 6-degree~~-~~s-of~~-~~-freedom motion simulating platform ~~in the early years~~ was proposed by the Englishman Steward~~, this type of 6-degree of freedom motion simulating platform was~~ and is customarily called the Stewart Platform. ——For a long time, there was no ~~any~~ significant ~~breakthrough of~~ improvement ~~or invention~~ in the ~~mechanism~~ design of the Stewart Platform, which ~~was still confined in the traditional idea of employing~~employed a hydraulic or pneumatic system to achieve the effect of changing the length of ~~the~~an actuating rod by varying the stroke of a cylinder rod to enable ~~a~~ 6-degree~~-~~s-of~~-~~-freedom spatial motion. Moreover, since the parts and components ~~constructing~~comprising the conventional Stewart Platform ~~are~~were not ~~in~~ modular in design~~,~~ and ~~the inherent drawback of~~ oil and air leakage problems occasionally occurred

with the hydraulic and pneumatic ~~system are always bother some that resulted in the inconvenience and disadvantage of replacing the parts and components in maintenance work. Therefore, the purpose~~systems, the Stewart Platform was inconvenient and required substantial maintenance.

## SUMMARY OF THE INVENTION

A goal of the present invention is to provide a solution to the above-described problems of the conventional Stewart Platform ~~as mentioned above~~ by employing ~~the~~a modular design ~~as the core of the invention in stead~~instead of the hydraulic or pneumatic system ~~adopted~~used by the conventional Stewart Platform.—

~~SUMMARY OF THE PRESENT INVENTION The major purpose~~ Another goal of the present invention is to provide a hex-axis horizontal movement dynamic simulator ~~which~~that can simulate the motion of 6 degrees of freedom without employing a hydraulic or pneumatic system.— ~~The minor purpose~~

A further goal of the invention is to provide a hex-axis horizontal movement dynamic simulator having a modular structure ~~which~~that comprises three modular movement control units of the same structure. The modular movement control units are located at ~~the~~ positions relative to each other forming three sides of an equilateral triangle and are pivoted to a load-carrying platform by ~~means of the~~a universal-joint yoke mechanism corresponding to

each of the three movement control units~~ to construct simulation platform for simulating the motion of 6 degrees of freedom. Another purpose~~.

A further goal of the invention is to provide a specific structure of ~~the~~a modular movement control unit ~~which~~that can precisely control the movement of the load-carrying platform~~,~~ and ~~enable~~provide a~~ structure of~~ motion simulation platform having 6 degrees of freedom.—

BRIEF DESCRIPTION OF THE ~~DRAWING FIGURES~~ DRAWINGS

FIG. 1 ~~is the pictorial drawing showing the structure of the~~illustrates a first embodiment of the hex-axis horizontal movement dynamic simulator of the invention ~~which~~that has three sets of movement control units of the same structure located separately at the positions forming three sides of an equilateral triangle.—

FIG. 2 ~~is the schematic drawing of~~illustrates the hex-axis horizontal movement dynamic simulator ~~shown in~~of FIG. 1 showing the variation of translation and angular motion of the load-carrying platform.—

FIG. 3 is a schematic drawing of the invention shown in FIG. 2 as viewed from ~~other~~another direction.—

FIG. 4 is ~~the~~a disassembly drawing showing the parts of the movement control unit ~~shown~~illustrated in FIG. 1.— ~~FIG. 5 is the pictorial drawing showing the structure of the second type of~~

FIG. 5 illustrates a second embodiment of the hex-axis horizontal movement dynamic simulator ~~of the invention~~ having three sets of movement control units of the same structure located separately at the positions forming three sides of an equilateral triangle.—

FIG. 6 is ~~the~~a disassembly drawing showing parts of the movement control unit ~~shown~~illustrated in FIG. 5.—

FIG. 7 ~~is the pictorial drawing showing the structure of the~~illustrates a third type of embodiment of the hex-axis horizontal movement dynamic simulator ~~of the invention~~ having three sets of movement control units of the same structure located separately at the positions forming three sides of an equilateral triangle.—

FIG. 8 is ~~the~~a disassembly drawing showing the parts of the movement control unit ~~shown~~illustrated in FIG. 7.—

DETAILED DESCRIPTION OF THE ~~PREFERRED EMBODIMENTS~~ INVENTION

~~Now refer~~Referring now to FIG. 1 and FIG. 2, ~~the~~a key point of the ~~present~~ invention is that no ~~any~~ hydraulic or pneumatic system ~~being~~is used ~~by the~~in a hex-axis motion simulator ~~(10) is employed. One end of both~~10. For each universal-joint yoke

mechanism 27, one end of each of two fixed-length connecting rods ~~(26) of fixed length~~ are pivoted to ~~a set of~~the universal-joint yoke mechanism ~~(27),~~ and the other ends of the connecting rods ~~(26)~~ are separately connected to ~~the~~a transmission-joint yoke mechanism ~~(25)~~. Further, ~~the said~~each transmission-joint yoke mechanism ~~(25)~~ is pivoted to a ~~set of~~ sliding seat ~~(24),~~ and the rectilinear translation motion and position of ~~the~~each transmission-joint yoke mechanism ~~(25)~~ is controlled by controlling the rectilinear translation and position of the corresponding sliding seat ~~(24) through which the connecting rod (26) is actuated~~ so as to generate a motion of 6 degrees of freedom ~~which in turn~~that controls the spatial motion and position of the load-carrying platform.—

~~The h~~Hex-axis horizontal movement dynamic simulator ~~(10) as depicted in the invention~~ comprises three movement control units ~~(20)~~, of the same structure ~~which~~, that are fixed on ~~the~~a foundation ~~(50)~~ at the locations relative to each other forming three sides of an equilateral triangle. Each of the three movement control units ~~(20)~~ is pivoted to the load carrying platform ~~(60)~~ by ~~means of~~ a universal-joint yoke mechanism ~~(27)~~. Thus the locations at which the three ~~sets of~~ universal-joint yoke mechanism~~(~~s 27~~)~~ are pivoted to the load-carrying platform ~~(60)~~ form an equilateral triangle.—

Each movement control unit ~~(~~20~~)~~ is symmetrically structured to comprise a ~~set of~~ universal-joint yoke mechanism ~~(~~27~~)~~, two connecting rods of fixed length ~~(~~26~~)~~, two ~~sets of~~ transmission-joint yoke mechanism~~(~~s 25~~)~~, two ~~sets of~~ sliding seat~~(~~s 24~~)~~, two lead screws ~~(~~23~~)~~, two ~~sets of~~ servo-driving mechanism~~(~~s 22~~)~~, and a ~~set of~~ rectilinear translation guide ~~(~~21~~)~~. Since ~~the~~ universal~~-~~-joint yoke mechanism ~~(~~27~~)~~ is pivotally connected to ~~the~~ load-carrying platform ~~(~~60~~)~~, it can generate a motion of 1 degree of freedom relative to ~~the~~ load-carrying platform ~~(~~60~~); and s~~. Since one end of each of the two connecting rods ~~(~~26~~)~~ is pivotally connected to the same universal-joint yoke mechanism ~~(~~27~~)~~, ~~then~~ the connecting rod can generate a motion of 2 degrees of freedom.

Therefore, the end ~~at which~~of the connecting rod ~~is~~ pivoted to the universal~~-~~-joint yoke mechanism ~~(~~27~~)~~ has 3 degrees of freedom~~s~~ for generating a spatial motion relative to the load-carrying platform. Further, ~~another~~the other ends of the two connecting rods are symmetrically pivoted to separate driving joint yoke mechanism~~(~~s 25~~)~~ that can generate a spatial motion of 2 degrees of freedom ~~also, s~~. Since the transmission-joint yoke mechanism ~~(~~25~~)~~ of each connecting rod ~~(~~26~~)~~ is pivoted to a ~~set of~~ sliding seat ~~(~~24~~)~~, the transmission-joint yoke mechanism ~~(~~25~~)~~ has 1 degree of freedom for generating a spatial motion relative to the sliding seat ~~(~~24~~)~~. Therefore,

the end ~~at which~~of the connecting rod ~~(~~26~~) is~~ pivoted to the transmission-joint yoke mechanism ~~(~~25~~)~~ has 3 degrees of freedom relative to the sliding seat ~~(~~24~~) in making a~~ for spatial motion ~~also~~.—

Based on the above-mentioned arrangement, both ends of each connecting rod ~~(~~26~~)~~ of each movement control unit ~~(~~20~~) all~~ have 3 degrees of freedom for generating a spatial motion~~, and, because~~. Since all~~ the~~ connecting rods are fixed-length rigid ~~body of fixed length~~bodies,~~ therefore~~ when the sliding seat ~~(~~24~~) makes a rectilinear displacement~~ is displaced rectilinearly, the transmission-joint yoke mechanism ~~(~~25~~)~~ on one end of the connecting rod ~~(~~26~~)~~ is restricted to ~~do~~ rectilinear translation together with the sliding seat ~~(~~24~~) that~~, which enables the connecting rod ~~(~~26~~)~~ to generate a spatial displacement of 6 degrees of freedom~~, and t~~. Through the variation of spatial position of every connecting rod ~~(~~26~~)~~, the universal-joint yoke mechanism ~~(~~27~~)~~ on ~~another~~the other end of the connecting rod ~~(~~26~~)~~ will generate a relative spatial-displacement following the rectilinear displacement of the transmission-joint yoke mechanism ~~(~~25~~)~~.—

Therefore, when the sliding seat ~~(~~24~~)~~ makes a rectilinear translation to another place together with the transmission joint yoke mechanism ~~(~~25~~) its~~ to which it is pivoted~~ to~~, the spatial position of the connecting rod ~~(~~26~~)~~ on the transmission~~-~~-joint

yoke mechanism ~~(~~25~~)~~ associated with 6 degrees of freedom will ~~varied,~~vary. That i~~.e.~~s, the universal-joint yoke mechanism ~~(~~27~~)~~ on one end of each connecting rod ~~(~~26~~)~~ will change~~s~~ its spatial position relative to the transmission~~-~~-joint yoke mechanism ~~(~~25~~),~~ and actuate the load-carrying platform ~~(~~60~~)~~ to ~~varying~~vary its spatial position.~~ Refer to~~

Each of FIGs. ~~1 through FIG. 3, corresponding~~1-3 corresponds to the rectilinear displacement of different sliding seats ~~(~~24~~)~~ ~~sliding~~, which slide on different movement control units ~~(~~20~~)~~ ~~which~~ that are respectively located at the positions forming three sides of an equilateral triangle~~, there will~~. The sliding seats 24 may have relative displacements ~~spatially generated by~~for the load-carrying platform ~~(~~60~~)~~. Therefore, through the synchronous and precise control of the rectilinear movement of each sliding seat ~~(~~24~~)~~ of each movement control unit ~~(~~20~~)~~, such as ~~the synchronous control of the rectilinear movement of each sliding seat (24) by~~may be provided by a computer system, the spatial movement of each ~~set of~~ universal-joint yoke mechanism ~~(~~27~~)~~ relative to ~~each~~the others can be precisely controlled to achieve a precise control of the motion of load-carrying platform ~~(~~60~~)~~ and to generate linear and angular displacement spatially.—

~~In the present invention t~~The mechanism ~~which~~that enables each sliding seat ~~(~~24~~)~~ of each movement control unit ~~(~~20~~)~~ to generate a rectilinear motion comprises two lead screws ~~(~~23~~)~~, two

~~sets of~~ servo-driving mechanism~~(~~s 22~~) including~~ having servo-motor~~(~~s 221~~)~~, a rectilinear translation guide ~~(~~21~~)~~ ~~including~~ having two guide seats ~~(~~212~~)~~ and two straight sliding rail~~(~~s 211~~)~~. Each sliding seat ~~(~~24~~)~~ has a female screw thread ~~which~~that engages with the lead screw ~~(~~23~~)~~. The servo-motor ~~(~~221~~)~~ of the servo-driving mechanism ~~(~~22~~)~~ is employed to drive the lead screw ~~(~~23~~)~~ to rotate~~ that~~, which enables the sliding seat ~~(~~24~~)~~ on one of the guide seats ~~(~~212~~)~~ of the rectilinear translation guide ~~(~~21~~)~~ to be guided by the straight sliding rail ~~(~~211~~)~~ and to generate~~ a~~ rectilinear displacement. Therefore, the rectilinear movement of each sliding seat ~~(~~24~~)~~ can be precisely controlled by the precise control of the rotating speed and angular displacement of the servo-motor ~~(~~221~~)~~ of each servo-driving mechanism ~~(~~22~~)~~, through which a precise control of the variation of linear and angular displacement of the load-carrying platform ~~(~~60~~)~~ can be achieved.

The first~~ type of~~ embodiment of the movement control unit ~~(20)~~ is shown in FIGs. 1~~ through FIG. 4, which~~-4 and comprises~~ at least~~ a base seat ~~(~~40~~)~~, a~~ set of~~ universal joint yoke mechanism ~~(~~27~~)~~, two connecting rods of fixed length ~~(~~26~~)~~, two~~ sets of~~ transmission-joint yoke mechanism~~(~~s 25~~)~~, two~~ sets of~~ sliding seat~~(~~s 24~~)~~, two lead screws ~~(~~23~~)~~, two~~ sets of~~ servo-driving mechanism~~(~~s 22~~)~~, and a rectilinear translation guide ~~(~~21~~)~~. The base seat ~~(~~40~~)~~ is a longitudinal plate fastened to the foundation ~~(~~50~~)~~

by bolt. The rectilinear translation guide ~~(~~21~~)~~ has two linear sliding rails ~~(~~211~~)~~ parallel to each other and two identical guide seats ~~(~~212~~)~~. The two linear sliding rails ~~(~~211~~)~~ are installed on the surface of the base seat ~~(~~40~~)~~ along the longitudinal direction of the base seat and parallel to each other, and the bottom side of each guide seat ~~(~~212~~) are~~ has two parallel guide slots ~~which are prepared to~~that match the shape and gauge of the two straight sliding rails ~~(~~211~~), t~~. Thus, each guide seat ~~(~~212~~)~~ can be installed on and match the two straight sliding rails ~~(~~211~~),~~ and slide on the two straight sliding rails along the guiding direction.—

Each servo-driving mechanism ~~(~~22~~)~~ comprises a servo-motor ~~(~~221~~)~~ assembled with a driving pulley ~~(~~222~~)~~, a driving belt ~~(~~223~~)~~, a driven pulley ~~(~~224~~)~~ and a bearing plate ~~(~~225~~) which~~ that drives a lead screw ~~(~~23~~)~~. The bearing plate ~~(~~225~~)~~ of each servo-driving mechanism ~~(~~22~~) are~~ is installed ~~in~~at a position near ~~both~~a different end~~s~~ of the base seat ~~(~~40~~)~~ so as to form ~~the~~a bracket for mounting the two lead screws ~~(~~23~~) by means of~~ with bearings and to have the two lead screws ~~(~~23~~)~~ parallel to the two straight sliding rails ~~(~~211~~);~~. The driving pulley ~~(~~222~~)~~ is mounted on the driving shaft of the servo-motor ~~(~~221~~)~~, and the driven pulley ~~(~~224~~)~~ is mounted on the lead screw ~~(~~23~~)~~. The driving pulley ~~(~~222~~)~~ and the driven pulley ~~(~~224~~)~~ are connected by the driving belt ~~(~~223~~)~~.—

The sliding seat ~~(~~24~~)~~ is~~ in~~ rectangular shaped and~~ is~~ fastened to the guide seat ~~(~~212~~)~~ of the rectilinear translation guide ~~(~~21~~)~~. On the sliding seat ~~(~~24~~)~~, two penetrating holes ~~(~~241~~)~~, ~~(~~242~~)~~ are prepared~~ of which the h~~. Hole ~~(~~241~~)~~ has a female screw thread~~,~~ and engages with the lead screw ~~(~~23~~), another~~. The other hole ~~(~~242~~)~~ is a passage for another lead screw ~~(~~23~~)~~ to pass through~~,~~. Further, on the top~~e~~ surface of each sliding seat ~~(~~24~~)~~, is a mounting recess ~~(~~243~~)~~ for pivotally mounting the transmission joint yoke mechanism ~~(~~25~~)~~.—

The transmission-joint yoke mechanism ~~(~~25~~)~~ comprises a U-shaped yoke ~~(~~251~~)~~ and a T-shaped pivot axis. The horizontal stub shaft formed on both sides of the T-shaped pivot axis ~~are~~is pivoted to the two vertical portions of the U-shaped yoke ~~(~~251~~)~~ by ~~means of~~a bearing and nut that enable~~s~~ the perpendicular stub shaft of the T-shaped pivot axis to have 1 degree of freedom of rotational motion relative to the U-shaped yoke ~~(~~251~~)~~. ~~Besides, o~~ On the bottom side of the U-shaped yoke ~~(~~251~~)~~, is a mounting shaft ~~(~~253~~) which~~ that is pivotally mounted to the mounting recess ~~(~~243~~)~~ by ~~means of~~a bearing and nut that ~~enables~~provide the transmission joint yoke mechanism ~~(~~25~~) to have~~ with 1 degree of freedom of ~~rotating~~rotational motion relative to the sliding seat ~~(~~24~~) it's pivoted to~~. ~~Or t~~ The perpendicular stub shaft of the T-shaped pivot axis ~~(~~252~~)~~ of each transmission-joint yoke mechanism ~~(~~25~~)~~ has 2 degrees of freedom of ~~rotating~~rotational motion

relative to the sliding seat ~~(~~24~~) it's~~ to which it is mounted~~ to~~.

The universal-joint yoke mechanism ~~(~~27~~)~~ comprises an inverse~~d~~ U~~-~~-shaped yoke ~~(~~271~~)~~, a cardan shaft ~~(~~272~~)~~, a neck-ring seat ~~(~~274~~)~~, and a cover plate ~~(~~275~~)~~. The left and right horizontal stub shafts formed on both sides of the cardan shaft ~~(~~272~~)~~ are pivoted to the two vertical portions of the inverse~~d~~ U~~-~~-shaped yoke ~~(~~271~~)~~ by ~~means of~~a bearing and nut ~~etc.~~ that enable~~s~~ the perpendicular stub shaft formed on the front and rear side of the cardan shaft (272) to have 1 degree of freedom of ~~rotating~~rotational motion relative to the inverse~~d~~ U~~-~~-shaped yoke ~~(~~271~~), moreover, o~~. On the top side of the inverse~~d~~ U~~-~~-shaped yoke ~~(~~271~~)~~, is a mounting shaft ~~(~~273~~) which~~ that is pivoted to the neck-ring seat ~~(~~274~~)~~ by~~ means of~~ a bearing~~, and a~~. A cover plate ~~(~~275~~)~~ is mounted on the upper side of the neck-ring seat ~~(~~274~~)~~, through which the whole assembly of the universal-joint yoke mechanism ~~(~~27~~)~~ is mounted on the load-carrying platform ~~(~~60~~), t~~. Thus, the inverse~~d~~ U~~-~~-shaped yoke ~~(~~271~~)~~ has 1 degree of freedom of ~~rotating~~rotational motion relative to the neck-ring seat ~~(~~274~~)~~ or the cover plate ~~(~~275~~) it is pivoted to, or t~~. The perpendicular stub shaft on the front and rear side of the cardan shaft ~~(~~272~~)~~ of the inverse~~d~~ U~~-~~-shaped yoke ~~(~~271~~)~~ has 2 degrees of freedom of ~~rotating~~rotational motion relative to the neck-ring seat ~~(~~274~~)~~ or cover-plate ~~(~~275~~)~~.

Every connecting rod ~~(~~26~~)~~ has a fixed length. On both ends of the connecting rod ~~(~~26~~)~~, are pivoting holes through which the front end of the connecting rod is pivotally connected to the front perpendicular stub shaft or rear perpendicular stub shaft of the cardan shaft ~~(~~272~~)~~ of the universal-joint ~~(~~27~~) that enables~~. Thus, the pivoting hole on the front end of the connecting rod ~~(~~26~~)~~ has 1 degree of freedom of ~~rotating~~rotational motion relative to the perpendicular stub shaft of the cardan shaft ~~(~~272~~) it's pivoted to, or, t~~. The pivoting hole on the front end of every connecting rod ~~(~~26~~)~~ has 3 degrees of freedom of ~~rotating~~rotational motion relative to the neck-ring seat ~~(~~274~~)~~ or cover plate ~~(~~275~~); Besides, t~~. The pivoting hole on the rear end of every connecting rod ~~(~~26~~)~~ is pivotally connected to the perpendicular stub shaft of the T-shaped pivot axis ~~(~~252~~)~~ by ~~means of~~a bearing and nut that ~~enables~~provide the pivoting hole on the rear end of every connecting rod ~~(~~26~~) to have~~ with 1 degree of freedom of ~~rotating~~rotational motion relative to the perpendicular stub shaft of the T-shaped pivot axis ~~(~~252~~) it's pivoted to, or, t~~. The pivoting hole on the rear end of every connecting rod ~~(~~26~~)~~ has 3 degrees of freedom of ~~rotating~~rotational motion relative to the sliding seat ~~(~~24~~) it belongs to~~.

Since each end of the connecting rod ~~(~~26~~)~~ has 3 degrees of freedom of ~~rotating~~rotational motion, the whole connecting rod ~~(~~26~~)~~ has 6 degrees of freedom for generating a spatial motion.

The above-mentioned mechanism, as verified by the equation of mobility in Spatial Mechanism, ~~is proved to be above to~~ generates a spatial motion of 6 degrees of freedom~~ i.e.~~, according to Gruebler~~1~~'s formula for a spatial mechanism:

$$F = 6(L - j - 1) + \sum_{i=1}^{j} f_i$$

$$L = 32, j = 36, \sum_{i=1}^{j} f_i = 36; F = 6$$

Where

F: Number of degrees of freedom of the whole mechanism

L: Total number of members in the mechanism

J: Total number of joints in the mechanism

$f_i$: The number of degree of freedom of the $i^{th}$ joint.

Therefore, the relative rotating angle and rotating speed of the servo-motor ~~(~~221~~)~~ of the servo-driving mechanism ~~(~~22~~)~~ of each movement control unit ~~(~~20~~)~~, based on the required data or condition of the relative motion of the load-carrying platform ~~(~~60~~)~~ in space and by applying the precise calculation and control of the computer system (not shown in drawings), can be synchronously controlled~~, and t~~. The sliding seat ~~(~~24~~)~~ and transmission-joint yoke mechanism ~~(~~25~~)~~ on each of the three movement control units can synchronously generate different

rectilinear movements to drive the connecting rod~~(~~s 26~~)~~ to generate relative spatial-displacement~~to~~s and control the relative spatial-movement of each universal-joint yoke mechanism ~~(~~27~~)~~, thus ~~enable~~enabling the load-carrying platform ~~(~~60~~)~~ to ~~generate different movement to attain the purpose of varying~~ vary its ~~of~~ posture and angular position ~~that can~~so as to simulate the state of a carrier (such as vehicle, ship, airplane and roller coaster etc.) ~~in~~ making a spatial motion of 6 degrees of freedom.

In the following, is another embodiment of the movement control unit ~~(~~20~~) which~~ that has the same mechanical structure ~~of~~and the same effect as that of the first ~~type~~ embodiment of the ~~movement~~ control unit ~~(~~20~~) as depicted in the above, and~~. This second embodiment applies the same technical ~~means~~ and actuating principle to enable the load-carrying platform ~~(~~60~~)~~ to simulate a spatial motion of 6 degrees of freedom. ~~However, t~~ The construction members and the inter-actuating relationship can be obtained by reference to the detailed description of the first ~~type~~ embodiment mentioned above, which shall not be repeated here~~,~~ ~~t~~. The following description ~~is only for~~describes the ~~structure of other type of~~second embodiment of the movement control unit ~~(~~20~~)~~.

The second ~~type of~~ embodiment of the movement control unit ~~(~~20~~)~~ is shown in FIGs. 5 and ~~FIG.~~ 6 ~~which~~and comprises ~~at least~~ a

machine bed (41), one~~ set of~~ universal-joint yoke mechanism (27), two fixed-length connecting rods~~ (26) of the fixed length~~, two ~~sets of~~ transmission-joint yoke mechanism~~(~~s 25), two~~ sets of~~ sliding seat~~(~~s 24), two lead screws (23), two servo-driving mechanism~~(~~s 22), and a rectilinear translation guide (21)~~ in which t~~. The components of the universal-joint yoke mechanism (27), the connecting rod (26), the transmission-joint yoke mechanism (25), the lead screw (23), the servo-driving mechanism (22), and the rectilinear translation guide (21) are~~ all~~ the same as those in the ~~aforesaid~~ first~~ type of~~ embodiment of the ~~present~~ invention.—

But, the machine bed (41) of the second~~ type of~~ embodiment of the invention is a rectangular stand made of a metal plate having an inverse~~d~~ U--shaped cross-section ~~which~~that is fastened on the foundation (50)~~, the~~. A cover plate (411) is mounted on both~~ of~~ the left and right ends of the machine bed (41)~~ having~~ with holes and an opening prepared ~~on~~at appropriate position~~, t~~s. The servo-motor (221) of the servo-driving mechanism (22) is installed inside the machine bed (41). The driving shaft of the servo-motor (221) extends ~~to the~~ outside~~ of~~ the machine bed (41). Through the opening o~~n~~f the cover plate (411) of the machine bed (41), a driving pulley (222) is mounted and fastened on the driving shaft of the driving-servo motor (221). Two support plates (227) of the servo-driving mechanism (22) are installed at~~ the~~ places closed to

both ends of the machine bed ~~(~~41~~)~~ to form the support for pivotally mounting the two lead screws ~~(~~23~~)~~ by ~~means of~~ bearings in a position parallel to the two straight sliding rails ~~(~~211~~)~~ of the rectilinear translation guide ~~(~~21~~)~~. The driven pulley ~~(~~224~~)~~ is mounted and fastened on the lead screw ~~(~~23~~)~~ with a transmission belt installed on and passing through the driving pulley ~~(~~222~~)~~ and driven pulley ~~(~~224~~)~~. Therefore, the driving power of the servo-motor ~~(~~221~~)~~ is transmitted to the lead screw ~~(~~23~~)~~ through the driving pulley ~~(~~222~~)~~, the transmission belt ~~(~~223~~)~~, and the driven pulley ~~(~~224~~)~~.

The sliding seat ~~(~~24~~)~~ employed in the second ~~type of~~ embodiment of the invention comprises ~~at least~~ a sliding block ~~(~~244~~)~~ and a neck ring seat ~~(~~246~~)~~. The sliding block ~~(~~244~~)~~ is fastened on the guide seat ~~(~~212~~)~~ of the rectilinear translation guide mechanism ~~(~~21~~)~~. On the sliding block ~~(~~244~~)~~, two holes are provided, one of which has a female screw thread~~,~~ and engages with a lead screw ~~(~~23~~), another~~. The other hole serves as the passage for another lead screw to pass through~~, t~~. The neck-ring seat ~~(~~246~~)~~ is fastened on the top~~e~~ side of the sliding block ~~(~~244~~),~~ or~~,~~ a fastening plate ~~(~~245~~) shall be~~ is installed on the top side of the sliding block ~~(~~244~~) at~~, first, and then ~~fasten~~ the neck-ring ~~(~~246~~)~~ is fastened on the fastening plate ~~(~~245~~)~~. The mounting shaft ~~(~~253~~)~~ of the U-shaped yoke ~~(~~251~~)~~ of the transmission-joint yoke mechanism ~~(~~25~~)~~ is pivoted to the circular access on the tope

side of the neck-ring seat ~~(~~246~~)~~ by ~~means of~~a bearing and related parts.—

~~What shall be mentioned here is that t~~The sliding seat ~~(~~24~~)~~ employed in the second ~~type of~~ embodiment and~~ the same in~~ the first embodiment can be exchanged and used in either of the two ~~types of~~ embodiment~~,~~s or in other embodiments of the invention.—

The third ~~type of~~ embodiment of the movement control unit ~~(~~20~~)~~ is shown in FIGs. 7 and ~~FIG.~~ 8 ~~which compresses at least~~and comprises a base seat ~~(~~40~~)~~, a~~ set of~~ universal-joint yoke mechanism ~~(~~29~~)~~, two fixed-length connecting rods ~~(~~26~~) of fixed length~~, two~~ sets of~~ sliding yoke mechanism~~(~~s 28~~)~~, two leading screws ~~(~~23~~)~~, two~~ sets of~~ servo-driving mechanism~~(~~s 22~~)~~, and a rectilinear translation guide ~~(~~21~~) wherein the said~~. The connecting rod ~~(~~26~~)~~, lead screw ~~(~~23~~)~~, servo-driving mechanism ~~(~~22~~)~~, and rectilinear translation guide ~~(~~21~~)~~ are the same as those employed in the first ~~type of~~ embodiment~~, and t~~. The structure of the universal-joint yoke mechanism ~~(~~29~~)~~ is similar to the sliding yoke mechanism ~~(~~28~~)~~.—

The universal-joint yoke mechanism ~~(~~29~~)~~ of the~~ aforesaid~~ third embodiment comprises an inverse~~d~~ U—-shaped yoke assembly ~~(~~291~~)~~, a pivoting plate ~~(~~293~~)~~, a pivoting shaft ~~(~~295~~)~~, two fixing blocks ~~(~~296~~)~~, an L—-shaped yoke plate ~~(~~297~~)~~, a fastening yoke plate ~~(~~298~~)~~, and two cover plates ~~(~~299~~)~~. The L—-shaped yoke plate is formed by a horizontal portion and a vertical portion. The

horizontal portion is fastened on the load-carrying platform ~~(60),~~ ~~and on the~~. A vertical portion hole is provided for mounting a shaft. The fastening yoke plate ~~(298)~~ is a plate~~-~~-shaped member with appropriate thickness having an appearance symmetric to that of the vertical portion of the L~~-~~-shaped yoke plate ~~(297)~~. ~~S~~ A shaft mounting hole is also provided on the fastening yoke plate ~~(298)~~, which is to be assembled with the L~~-~~-shaped yoke plate ~~(297)~~ to form a yoke assembly. The pivoting plate ~~(293)~~ is ~~in~~ rectangular shape with a pivoting access in its center position and horizontal stub shafts ~~(294)~~ extended symmetrically from both sides opposite to each other ~~which are~~that pivotally mount~~ed~~ in the hole on the L~~-~~-shaped yoke plate ~~(297)~~ and the fastening yoke plate ~~(298)~~ by ~~means of~~ bearings and related parts~~, t~~. The two cover plates are fastened on one side of the vertical portion of the L~~-~~-shaped yoke plate ~~(297)~~ and the fastening yoke plate ~~(298)~~ to fix the whole assembly ~~that enables~~and provide the pivoting plate ~~(293) to have~~ with 1 degree of freedom of ~~rotating~~rotational motion relative to the L~~-~~-shaped yoke plate ~~(297)~~ and the fastening yoke plate ~~(298) its fastened to,~~. The yoke assembly ~~(291)~~ has a mounting shaft ~~(292)~~ extended upwardly from its top side and is mounted in the pivoting access in the center position of the pivoting plate ~~(293)~~ by ~~means of~~a bearing, and a cover is fastened on the mounting surface of the pivoting plate to fix the assembly. Therefore, the yoke assembly has 1 degree of freedom of

~~rotating~~rotational motion relative to the pivoting plate 293 ~~its pivoted to, or~~and has 2 degrees of freedom of motion relative to the L~~—~~-shaped yoke plate ~~(~~297~~)~~ and the fastening yoke plate ~~(~~298~~),~~. The bottom side of the two flanks of the yoke assembly ~~(~~291~~)~~ has a semicircular recess, and the fixing block ~~(~~296~~)~~ also has a corresponding semicircular recess on the top side. A shaft ~~(~~295~~)~~ is pivotally installed by fixing the two fixing blocks on the bottom side of the two flanks of the yoke assembly ~~(~~291~~)~~, and both ends of the pivoting shaft ~~(~~295~~)~~ can be pivotally connected to the connecting rod ~~(~~26~~) that enables~~ so as to provide the pivot hole on the front end of each connecting rod ~~has~~with 1 degree of freedom of ~~rotating~~rotational motion relative to the yoke assembly ~~(~~291~~) it's pivoted to, or, has~~ and 3 degrees of freedom of ~~rotating~~rotational motion relative to the L~~—~~-shaped yoke plate ~~(~~297~~)~~ and the fastening yoke plate ~~(~~298~~)~~.~~—~~

The sliding yoke mechanism ~~(~~28~~)~~ employed in the third embodiment comprises a U~~—~~-shaped yoke assembly ~~(~~281~~)~~, a pivoting plate ~~(~~283~~)~~, a shaft ~~(~~285~~)~~, two fixing blocks ~~(~~286~~)~~, an L~~—~~-shaped sliding yoke plate ~~(~~287~~)~~, a sliding fastening plate ~~(~~288~~)~~, and two cover plates ~~(~~289~~)~~. The ~~said~~ L~~—~~-shaped sliding yoke plate ~~(~~287~~)~~ has a horizontal portion and a vertical portion~~,~~ and is fastened on the guide seat ~~(~~212~~)~~ of the rectilinear translation guide ~~(~~21~~)~~ through its horizontal portion. ~~Besides, t~~The L~~—~~-shaped sliding yoke plate ~~(~~287~~)~~ has two penetrating holes, one of which has a

female screw thread~~,~~ and engages with the lead screw ~~(~~23~~),~~ ~~another~~. The other hole serves as a passage for another lead screw ~~(~~23~~)~~ to pass through. In addition, the vertical portion of the L~~-~~-shaped sliding yoke plate ~~(~~287~~)~~ has a pivoting hole. The sliding fastening plate ~~(~~288~~)~~ is a plate~~-~~-shaped member ~~with~~of appropriate thickness ~~having~~and has an appearance symmetric to that of the vertical portion of the L~~-~~-shaped sliding yoke plate. Two penetrating holes and a pivoting hole are provided on the sliding fastening plate ~~(~~288~~) of which t~~. The two penetrating holes are for the two lead screws ~~(~~23~~)~~ to pass through. A yoke assembly is formed by assembling the sliding fastening plate ~~(~~288~~)~~ and the L~~-~~-shaped sliding yoke plate ~~(~~287~~)~~. The pivoting plate ~~(~~283~~)~~ is~~ in~~ rectangular shaped with a pivoting access in a center position and horizontal stub shafts ~~(~~284~~)~~ extended symmetrically from both sides opposite to each other ~~which are~~that pivotally mount~~ed~~ in the hole on the L~~-~~-shaped sliding yoke plate ~~(~~287~~)~~ and the sliding fastening yoke plate ~~(~~288~~)~~ by ~~means of~~a bearing and related parts~~, and then t~~. Two cover plates are fastened on one side of the vertical portion of the L~~-~~-shaped sliding yoke plate ~~(~~287~~)~~ and the sliding fastening plate ~~(~~288~~)~~ to fix the whole assembly so that~~ enables~~ the pivoting plate ~~(~~283~~)~~ has 1 degree of freedom of ~~rotating~~rotational motion relative to the L~~-~~-shaped sliding yoke plate ~~(~~287~~)~~ and the sliding fastening plate ~~(~~288~~)~~ ~~it's pivoted to.~~. The yoke assembly ~~(~~281~~)~~ has a mounting shaft

(282) extended downwardly from its bottom side ~~which~~that is pivotally mounted in the pivoting access in the center position of the pivoting plate (283) by ~~means of~~a bearing and~~ the~~ related parts~~, and a~~. A cover is fastened on the pivoting plate (283) to fix the assembly~~, therefore~~. Thus, the U-shaped yoke assembly (281) has 1 degree of freedom of ~~rotating~~rotational motion relative to the pivoting plate (283~~), or~~ and has 2 degrees of freedom of ~~rotating~~rotational motion relative to the L-shaped sliding yoke plate (287) and the sliding fastening plate (288). The top~~e~~ side of the two vertical portions of the U-shaped yoke assembly has a semicircular recess, and ~~the~~a corresponding semicircular recess is ~~also~~ provided on the fixing block (286) on the bottom side. A shaft (285) is pivotally installed by fixing the two fixing blocks (286) on the top side of the U-shaped yoke assembly, and both ends of the pivoting shaft (285) can be pivotally connected to the connecting rod (26~~) that enables~~ so as to provide the pivot hole on the rear end of the connecting rod (26~~) has~~ with 1 degree of freedom of ~~rotating~~rotational motion relative to the U-shaped yoke assembly (281~~), or has~~ and 3 degrees of freedom of ~~rotating~~rotational motion relative to the L-shaped sliding yoke plate (287) and the sliding fastening plate (288). Since ~~either of the two~~both ends of the connecting rod (26) ha~~s~~ve 3 degrees of freedom of ~~rotating~~rotational motion, each

connecting rod ~~(26) shall~~ hav~~e~~s 6 degrees of freedom of ~~rotating~~rotational motion in space.